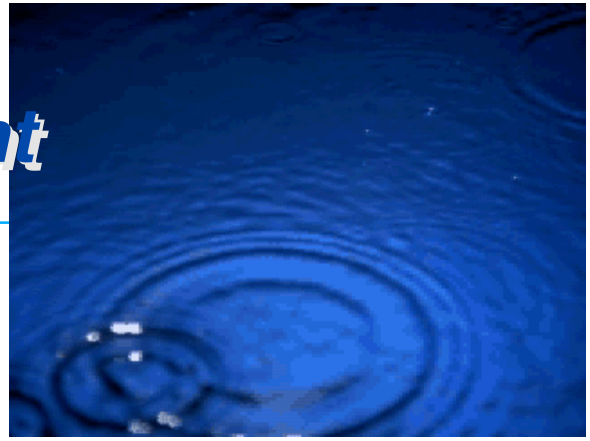
GPM
Global Precipitation Measurement

Science Status - NASA



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5th GPM International Planning Workshop
November 7-9, 2005, Tokyo, Japan

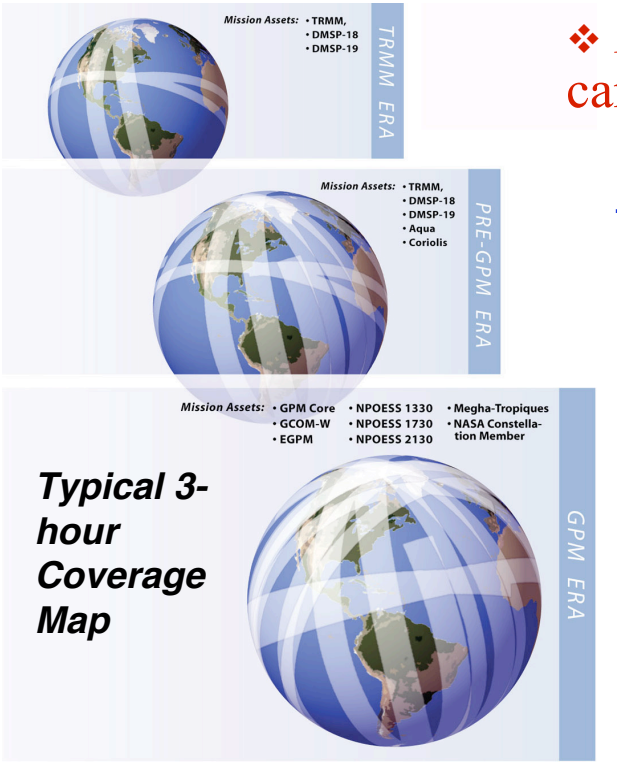
2005 GPM Science Milestones

- ***White paper on scientific rationale for GMI HF channels*** *(Kakar/Shepherd/Smith et al.), April 2005*
  - *GMI HF capability approval, September 2005*
- ***Formation of GPM Advisory Panel on Ground Measurements*** *(Chair: C. Kummerow/Colorado State University)*
  - *First meeting, 9-10 August 2005*
  - *White Paper completed, 30 September 2005*
- ***2nd International GPM Ground Validation Workshop, 27-29 September 2005, Taipei, Taiwan***
- ***IPWG/GPM/GRP Workshop on Global Microwave Modeling and Rainfall Retrieval of Snowfall, 11-13 October, Madison, WI***
- ***U.S. National Academies Meeting on the Future of Precipitation Missions, 18-19 October 2005, Washington, DC***
- ***5th GPM International Planning Workshop, 7-9 November 2005, Tokyo, Japan***
- ***NASA Precipitation Measurement Missions (PMM) Science Team Meeting, 12-15 December 2005, Monterey, CA***

Outline of Presentation

- *Overview of the GPM concept*
- *New measurement capabilities*
- *NASA GPM science objectives*
- *Measurement requirements*
- *Minimum sampling requirements*
- *Ground validation strategy*
- *Near-term plans*

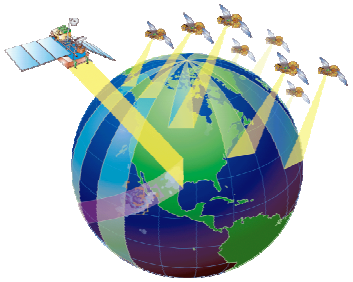
Evolution of Precipitation Measurement Missions



Typical 3-hour Coverage Map

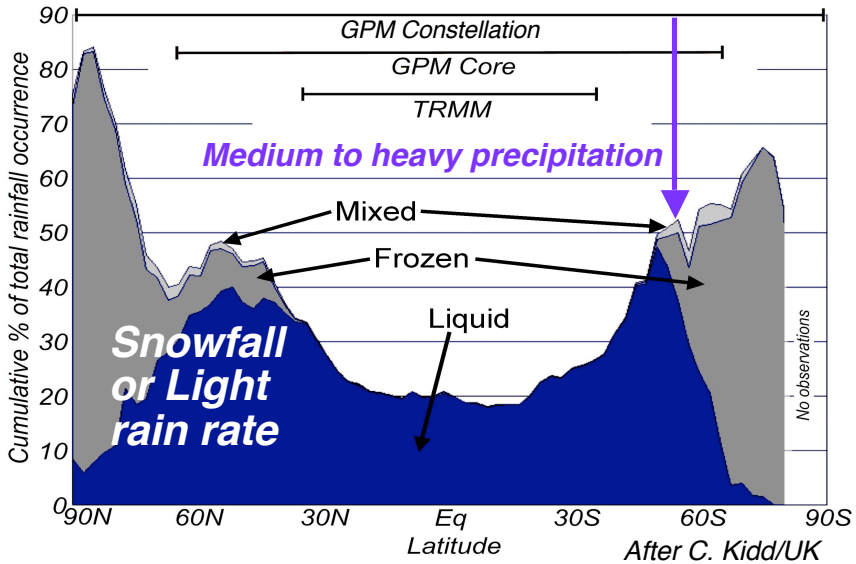
❖ *NASA/JAXA* GPM Core Satellite carries:

- a dual-frequency radar &
- a passive microwave imager with high-frequency capabilities



to provide a precipitation physics observatory and a calibration system for a constellation of dedicated and operational PMW radiometers.

❖ *NASA* contributes a "wild card" Constellation Satellite to optimize the global sampling.

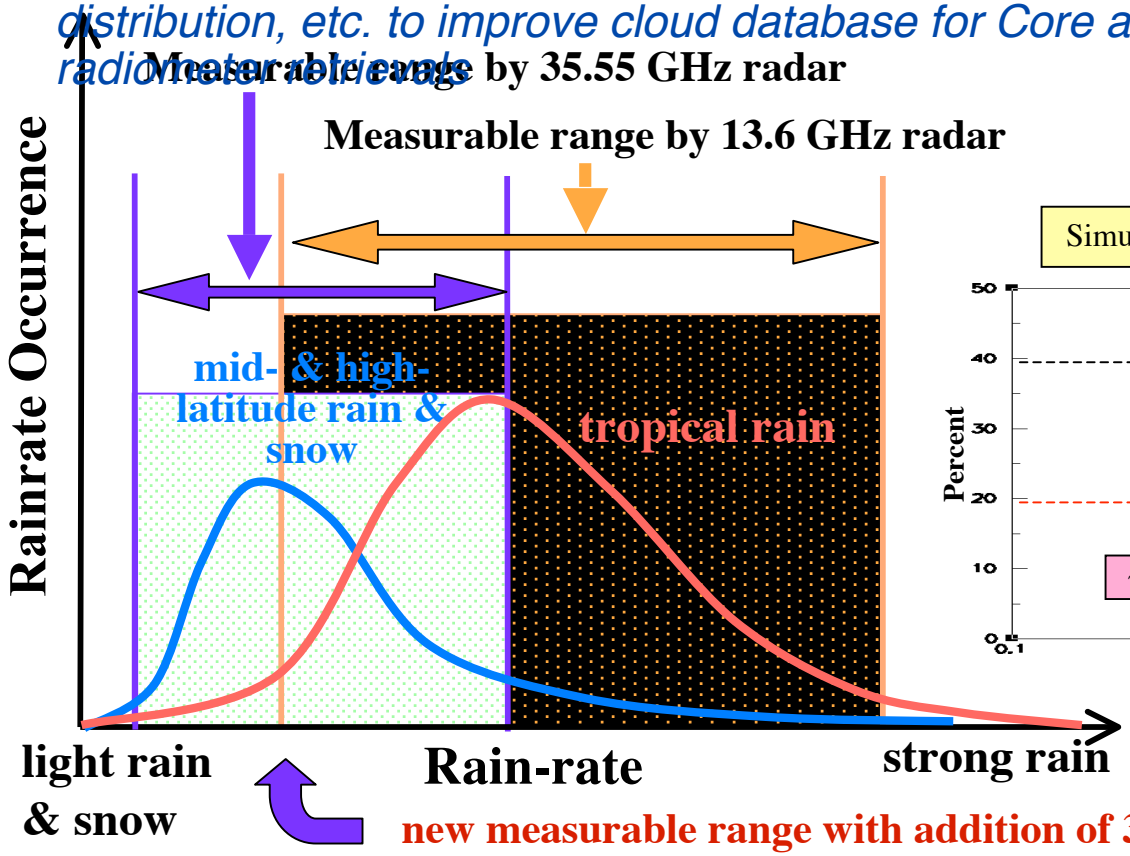


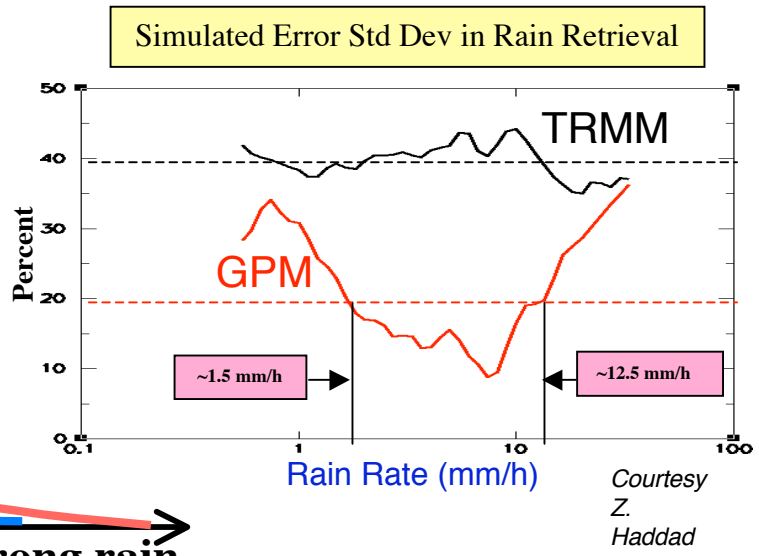
GPM Science Challenge:

Measurement of light rain & snowfall over ocean and land

JAXA/NICT Dual-Frequency Precipitation Radar

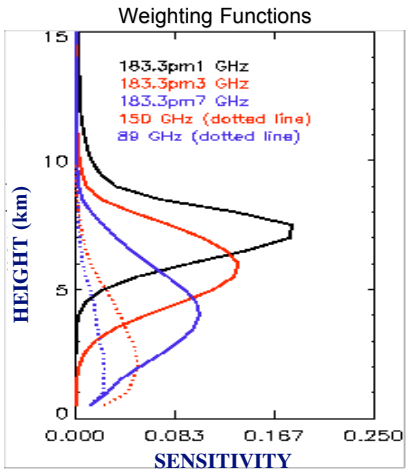
- ***Increased sensitivity for light rain and snow detection*** – *extending the detection threshold from 18 to 11 dBZ (0.5 to 0.17 mm/h)*
- ***Better overall measurement accuracy*** - *replacing the surface reference technique for path-integrated-attenuation correction with dual-frequency methods*
- ***More detailed microphysical information*** – *estimation of drop size distribution, etc. to improve cloud database for Core and constellation radiometer retrievals*



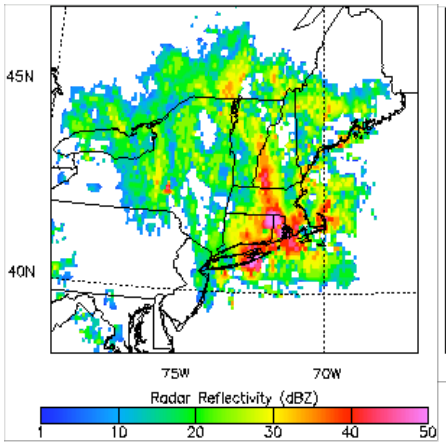


Science values of HF capability on GMI

- ***Measurement of frozen precipitation***
- ***Measurement of light rain***
- ***Improved PMW retrieval algorithms over land***
- ***Improved precipitation measurements in mid- and high-latitudes in cold seasons***
- ***HF channels on GPM Core enabling the testing and evaluation of constellation PMW algorithms using the DPR***

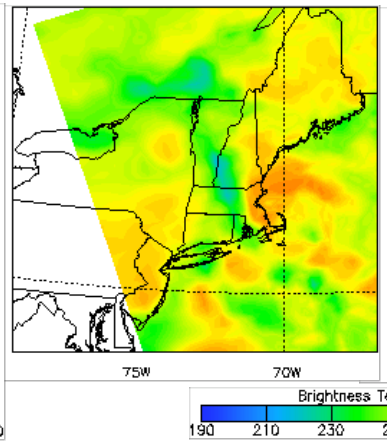


NOAA NEXRAD Data



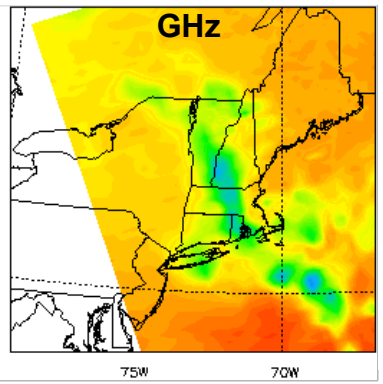
Radar reflectivity composite of the March 5-6, 2001 New England blizzard (75 cm of snow fell on Burlington, VT)

AMSU-B 89 GHz



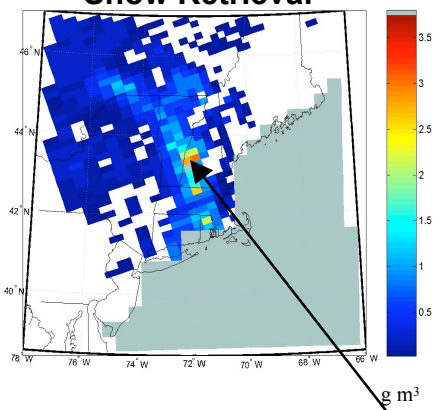
Surface effects evident over the Great Lakes, the St. Lawrence River, and along the Atlantic coast. Cannot distinguish surface from cloud effects.

AMSU-B 183.3 ± 7 GHz



Surface effects screened by water vapor. Snowfall appears over New England as low brightness temperatures

Snow Retrieval



Feasibility demonstration of snowfall retrieval using HF channels

4 in/h

G. Skofronick-Jackson et al. (GSFC)

GPM Science Objectives

- ***Advancing precipitation measurement capability from space:***
  - *through combined use of active and wide-band passive remote-sensing techniques*
- ***Advancing understanding of global water/energy cycle variability and fresh water availability:***
  - *through better measurement of the space-time variability of global precipitation*
- ***Improving weather forecasting skills:***
  - *through more accurate and frequent measurement of instantaneous rain rates*
- ***Improving climate modeling & prediction capabilities:***
  - *through better understanding of precipitation microphysics, surface water fluxes, soil moisture storage, and atmospheric latent heating distribution*
- ***Improving prediction capabilities for floods, droughts, fresh water resources, crop conditions, & other water-related applications:***
  - *through improved temporal sampling and high-resolution spatial coverage*

A science mission with integrated applications goals

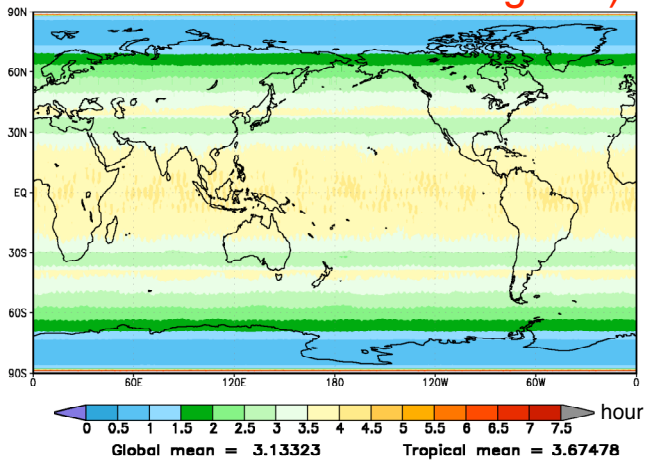
GPM Measurement Requirements

- ***Measurement range*** *- 0.3 to 110 mm/h over land and ocean*
- ***Discrimination between convective & stratiform precipitation types***
- ***Detection of snowfall***
- ***Estimation of drop size distribution of precipitating particles***
- ***Estimation of 3-D latent heat release***
- ***Horizontal resolution*** *– 5 km between 65^{o}N and 65^{o}S*
- ***Vertical resolution*** *– 0.25 km between 65^{o}N and 65^{o}S*
- ***Coverage and Sampling*** *– average revisit time of 3h or less over 80% of the globe*
- ***Accuracy of instantaneous surface rain rates*** *– biases of ~10% or less at 50 km resolution relative to calibrated ground validation data*
- ***Precision of instantaneous surface rain rates*** *- random errors of ~25% or less at 10 mm/h and 50% or less at 2 mm/h at 50 km resolution over ocean relative to calibrated ground validation data. Over land, the requirements are relaxed by a factor of two.*
- ***Error characterizations of instantaneous surface rain rates, associated radar reflectivity, and microwave brightness temperatures***

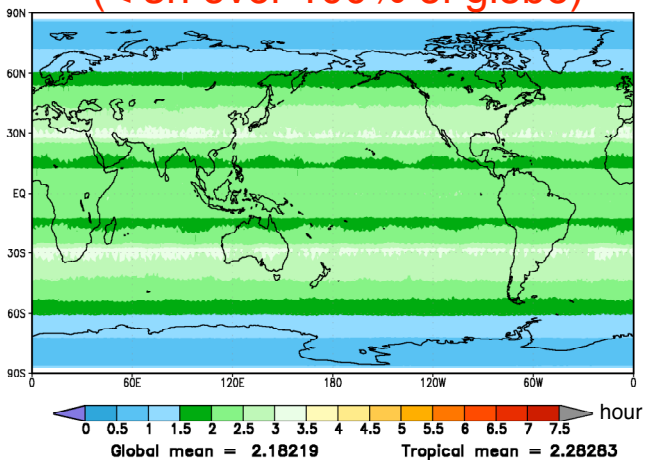
GPM Sampling & Coverage: Mean Revisit Times by PMW radiometers

Current: (< 3h over 35% of globe
< 4h over 91% of globe)

TRMM
Aqua
F13
F14
F15



Expected GPM-Era:
(< 3h over 100% of globe)

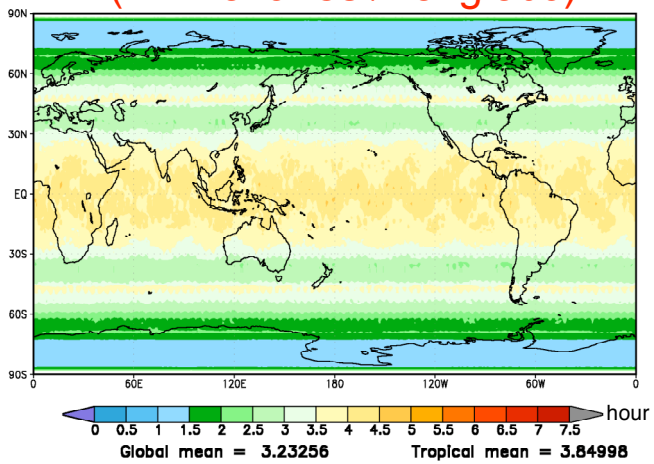


Core
GCOM-W
EGPM
3 NPOESS's
NASA-90º
Megha-Tropiques

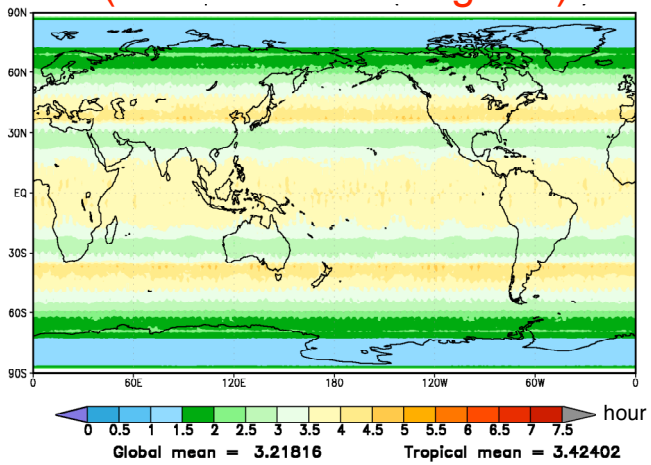
Minimum science requirement: 4h revisit time over 80% of globe

(< 4h over 83% of globe)

Core
F18
F19
NPEOSS-1
NASA-40º



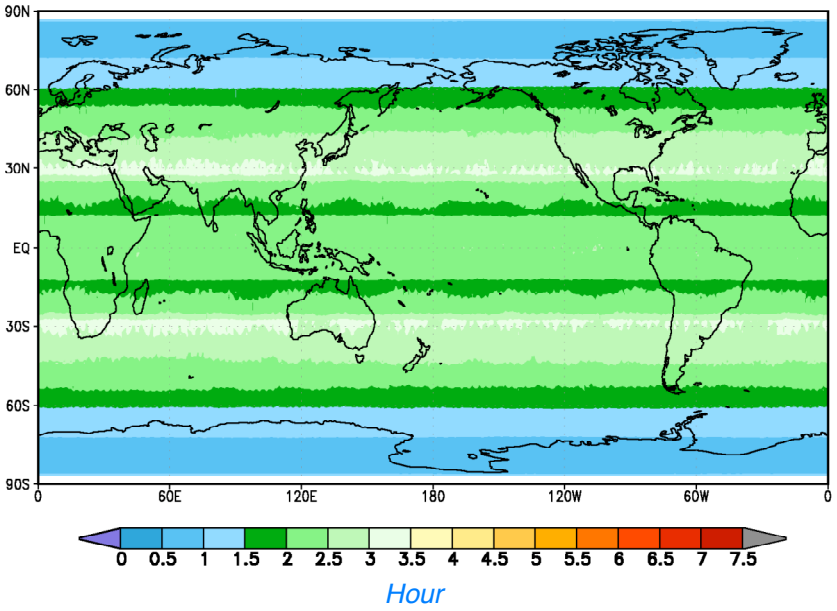
(< 4h over 98% of globe)



Core
F18
F19
NPEOSS-1
NASA-30º

Example of Temporal Sampling Over 2 Days

GPM Core, GCOM-W, NASA-90^o EGPM, 3 NPOESS's

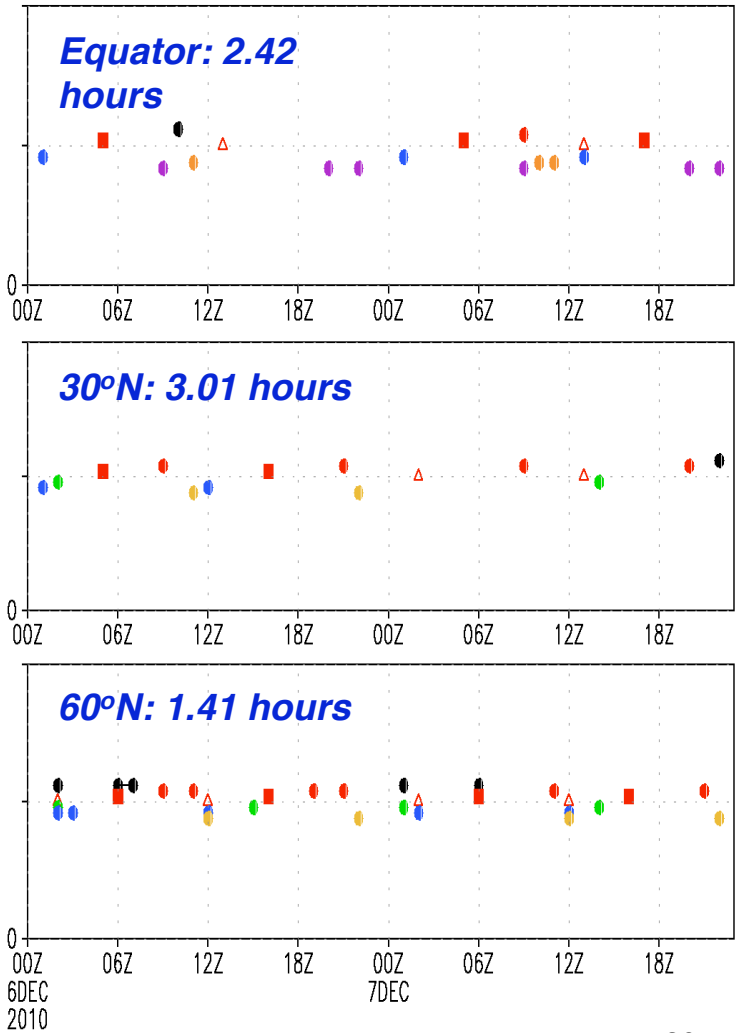


(< 3h over 100% of globe)

CORE: black circle
NPOESS1: red circle
NPOESS2: red square
NPOESS3: red triangle

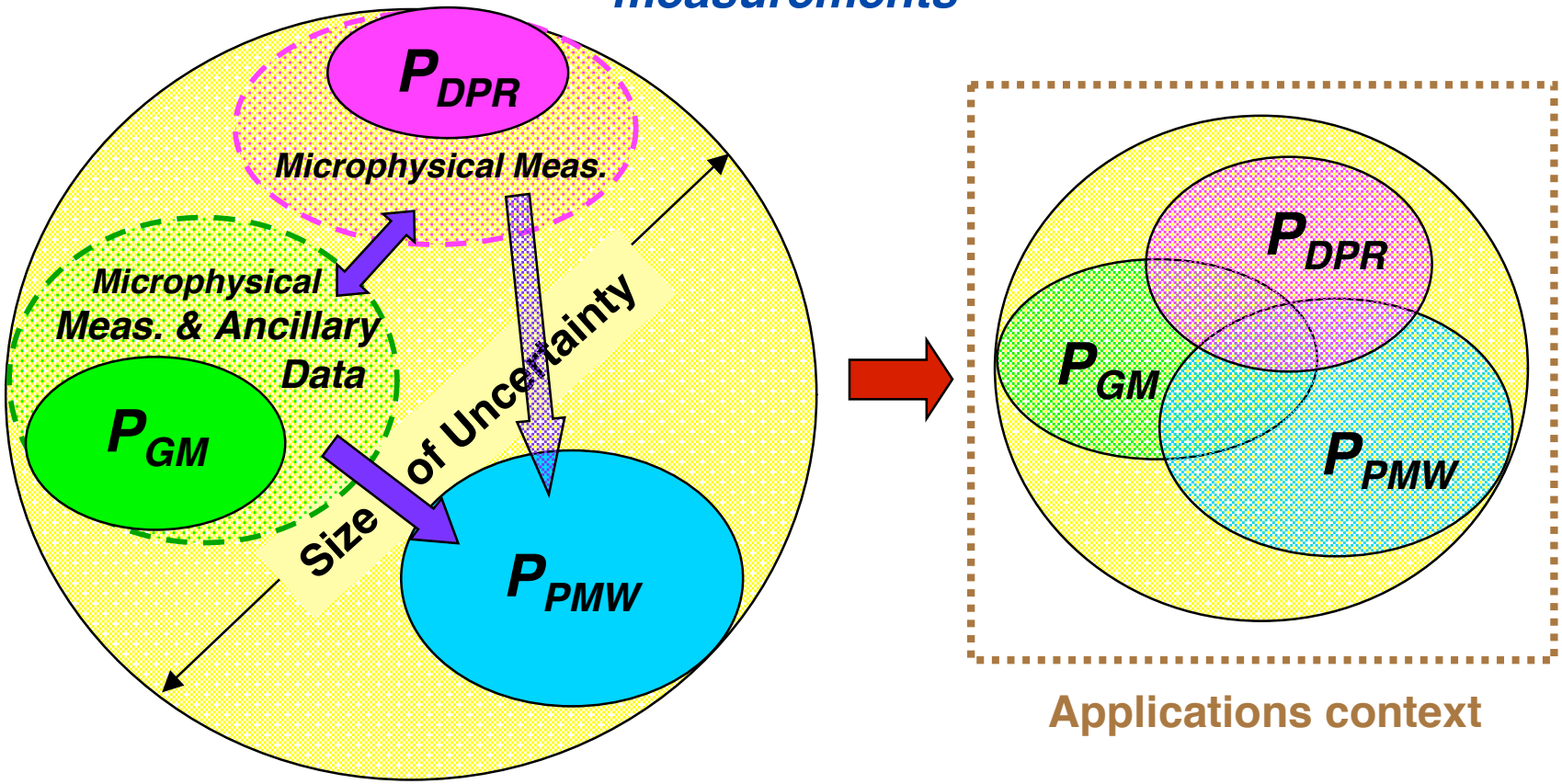
EGPM: green circle
GCOM-W: blue circle
NASA1 (Inc=90): orange circle
M-T: purple circle

Revisit times at 0 E: December 6-7, 2010



GPM Validation Concept

GPM validation goes beyond direct comparisons of surface precipitation rates between ground and satellite measurements



Providing additional measurements to reduce uncertainties & assumptions in forward models that relate precipitation to satellite measurements for algorithm improvements

- ***Surface precipitation statistical validation sites for direct assessment of GPM satellite data products:***
  - *Leveraging off existing or upgraded national radar and gauge networks from countries around the world to identify and resolve significant discrepancies between the national network and satellite estimates*
- ***Precipitation process sites for improving understanding and modeling of precipitation physics in physical and radiance spaces for satellite retrieval algorithm improvements:***
  - *Continental tropical, mid- and high-latitude sites (including orographic/coastal sites and targeted sites for resolving discrepancies between satellite algorithms)*
  - *Oceanic tropical and mid-latitude sites*
  - *Aircraft measurements* (Sites of different categories can overlap.)
- ***Integrated hydrological sites for improving hydrological applications:***
  - *Co-located with existing watersheds maintained by other US agencies and international research programs (e.g., GEWEX, GEOSS) to use hydrological basins as an integrated measure of the goodness of precipitation products*

Opportunities for international GV partnerships

Near-Term Plans

- ***PMM Science Team completing the Science Implementation Plan by mid-2006 before the PDR.***
- ***Establishing a PMM Algorithm Working Group to develop - in consultation with partner science teams - an algorithm R&D strategy to ensure a seamless transition from TRMM to GPM data products.***
- ***Developing a GPM GV implementation plan guided by recommendations of the Advisory Panel on Ground Measurements***
  - *To demonstrate the soundness of the GV concept*
  - *To establish scientific and programmatic collaborations with domestic and international GV partners*